

COMPUTATIONAL CONTROLS FOR AEROSPACE SYSTEMS

JPL

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12 JULY 1988

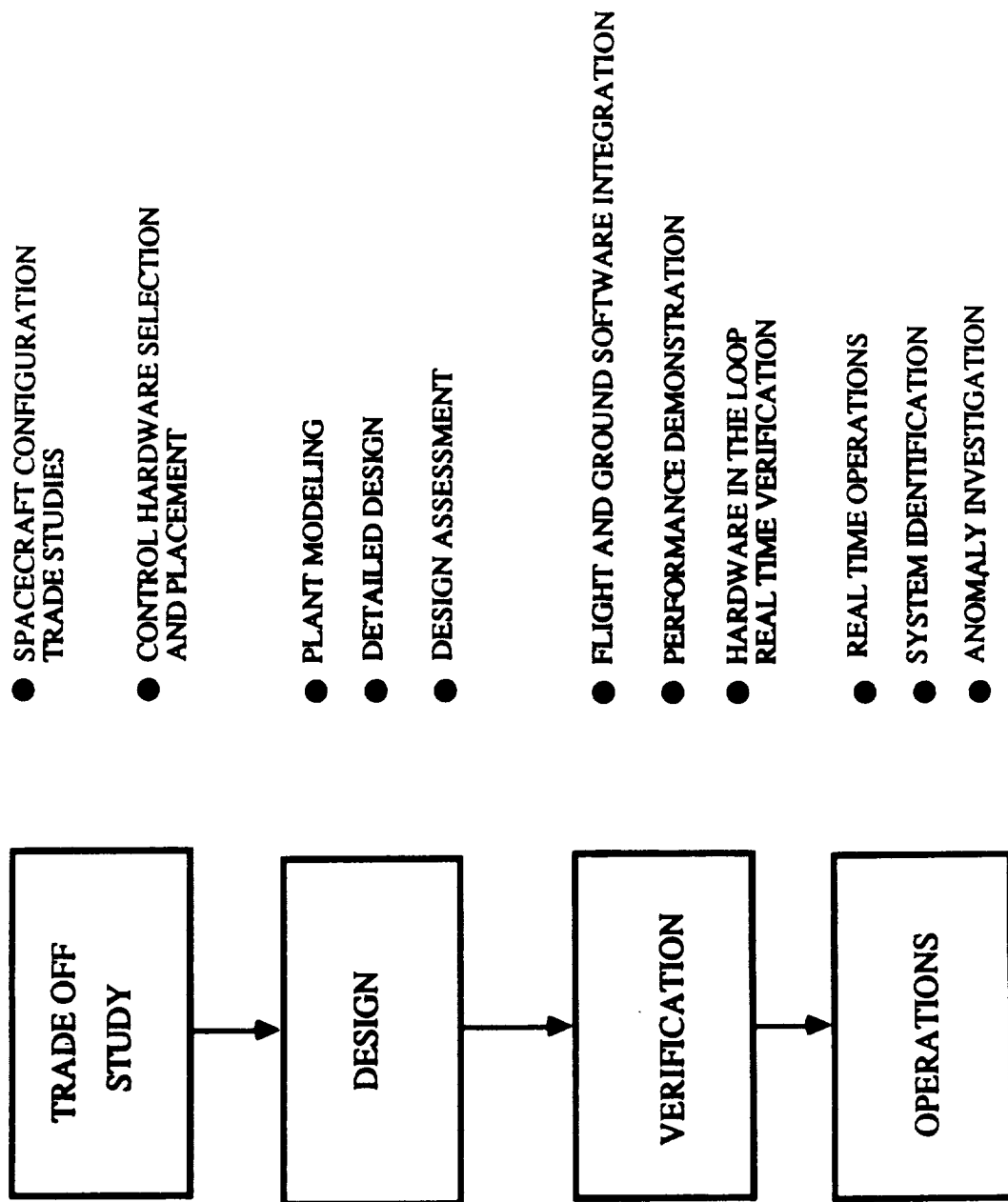
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COMPUTATIONAL CONTROLS OBJECTIVE

To find

DEVELOP THE NEXT GENERATION GUIDANCE AND CONTROL
ANALYSIS AND DESIGN TOOLS TO ENABLE FUTURE MISSIONS
AND TO IMPROVE PRODUCTIVITY AND RELIABILITY.

TOOLS FOR CONTROL SYSTEM DEVELOPMENT



TOOLS ARE INDISPENSIBLE FOR CONTROL SYSTEM DEVELOPMENT

GOALS FOR NASA COMPUTATIONAL CONTROL

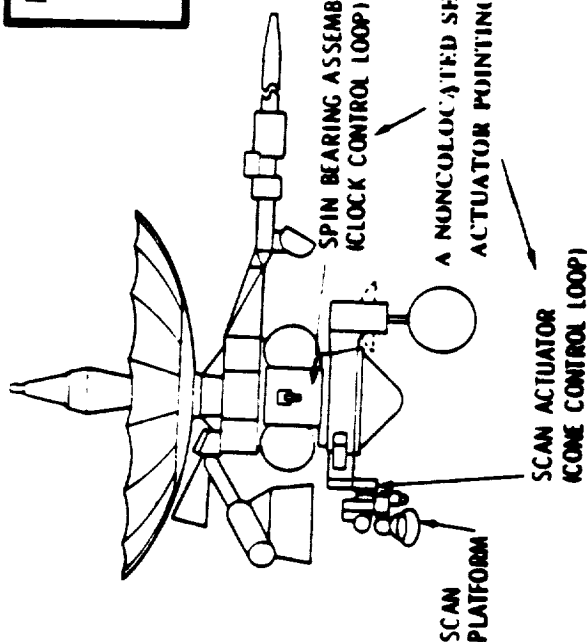
- IMPROVE QUICK-DESIGN TURN AROUND TIME BY A FACTOR OF 16
(4 MONTHS → 1 WEEK)
- IMPROVE EVALUATION TURN AROUND TIME BY A FACTOR OF 40
(10 MONTHS→ 1 WEEK)
- ENABLE REAL TIME HARDWARE-IN-THE-LOOP SIMULATION OF
COMPLEX SPACECRAFT
- ENABLE REAL TIME ANOMALY INVESTIGATION FOR OPERATIONS
- ENABLE TOOLS TO HANDLE 300 STATES BY 1992 AND 1000 STATES BY 1996

RATIONALE

- LACK OF QUICK-DESIGN TOOLS TO IMPACT SPACECRAFT DESIGN
- LACK OF EFFECTIVE EVALUATION TOOLS TO CHECK DESIGN MARGIN & PERFORMANCE
- LACK OF REAL TIME SIMULATION TOOL OF REALISTIC SPACECRAFT TO CERTIFY DESIGN
- LACK OF QUICK DIAGNOSTIC TOOLS FOR MISSION OPERATIONS

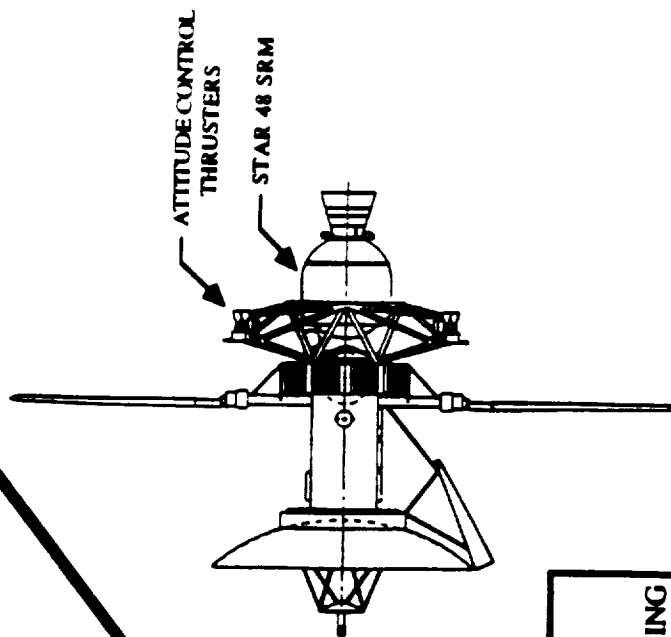
**LACK OF PROPER TOOL CREATES
INTOLERABLE RISK FOR FUTURE
SPACECRAFT SYSTEMS**

THE GALILEO CONTROL DESIGN PROBLEM



PROBLEM:

LACK OF QUICK-LOOK TOOL
LEADS TO FAILURE TO MEET
MISSION REQUIREMENTS



PROBLEM:

LACK OF EFFECTIVE EVALUATION
TOOL PROHIBITS US FROM IDENTIFYING
A MISSION CATASTROPHIC FAILURE
DURING VENUS ORBIT INSERTION

MAGELLAN SPACECRAFT VENUS ORBIT INSERTION PROBLEM

GALILEO CONTROL SYSTEM REAL TIME TESTING

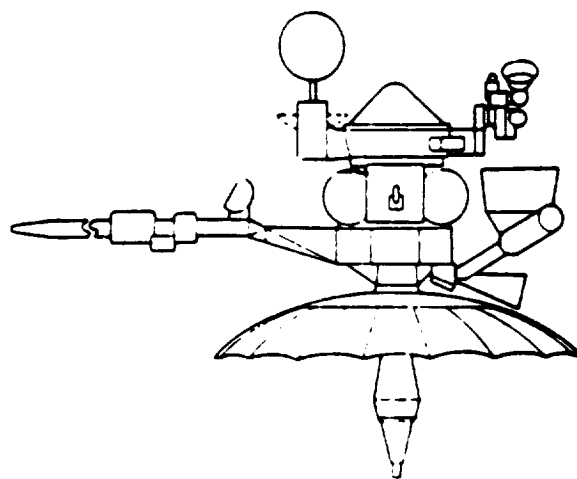
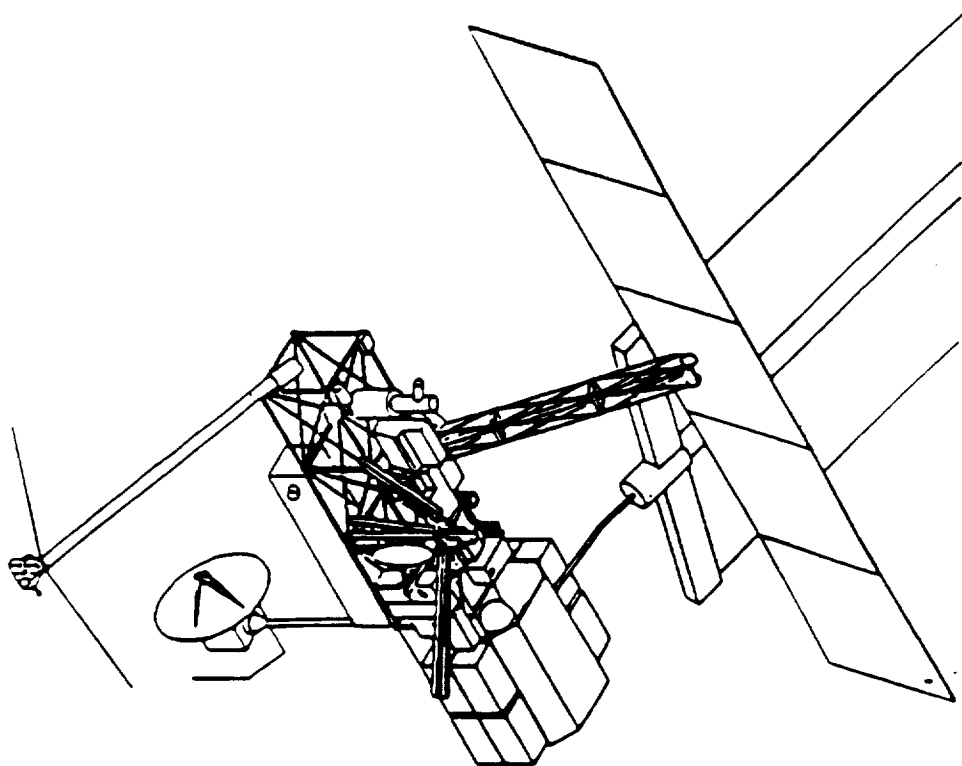


Galileo AACs
Test Area
SECTION 341

PROBLEMS:

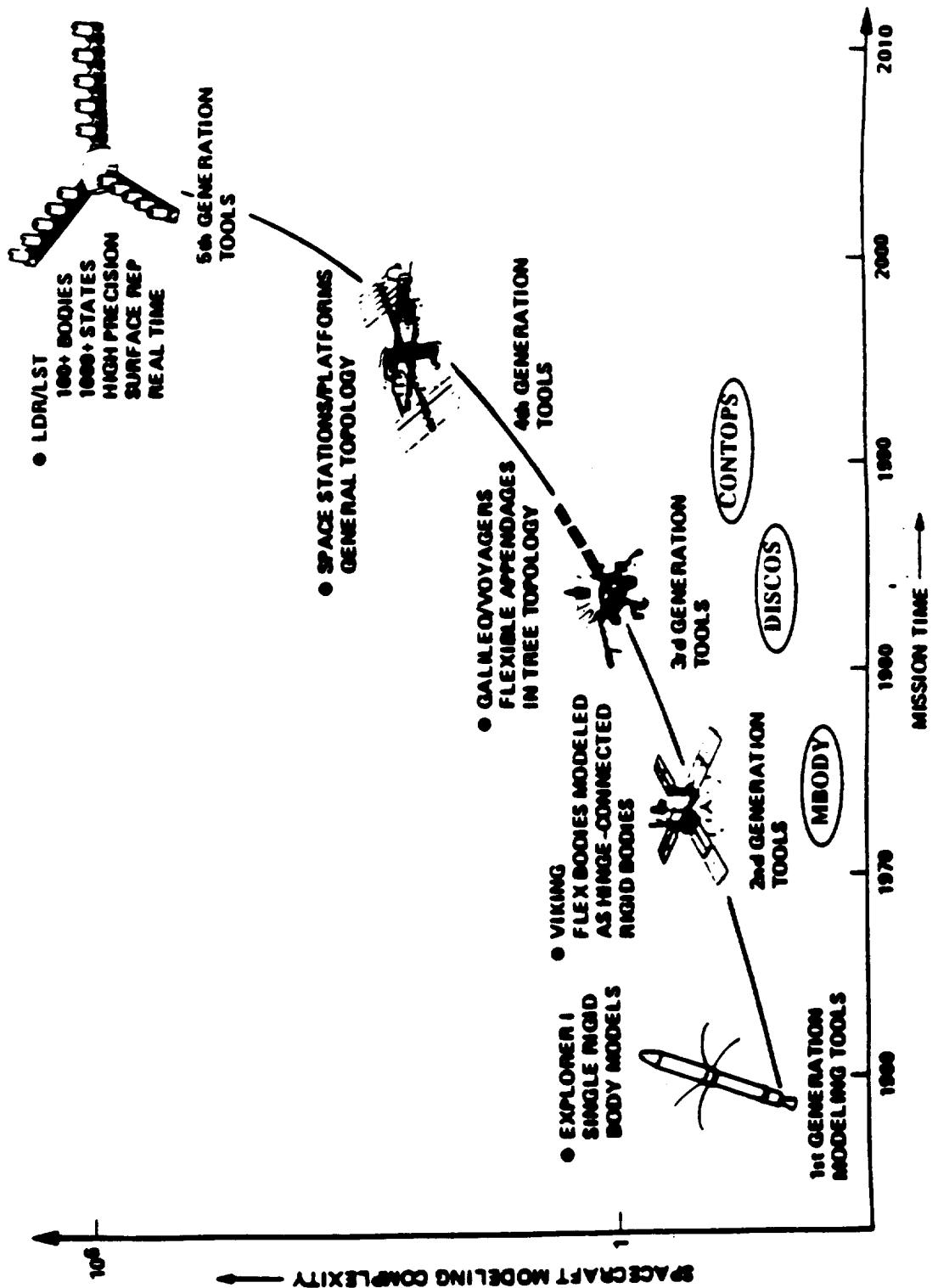
- THE ATTITUDE AND ARTICULATION CONTROL SYSTEM IS THE ONLY SPACECRAFT SUBSYSTEM WHICH CANNOT BE TESTED ON THE GROUND
- THERE IS A LACK OF REAL TIME SIMULATION TOOL TO CHECK CONTROL SYSTEM ROBUSTNESS FOR TODAY'S CONTROL PROBLEM

MISSION OPERATIONS SUPPORT IS INADEQUATE

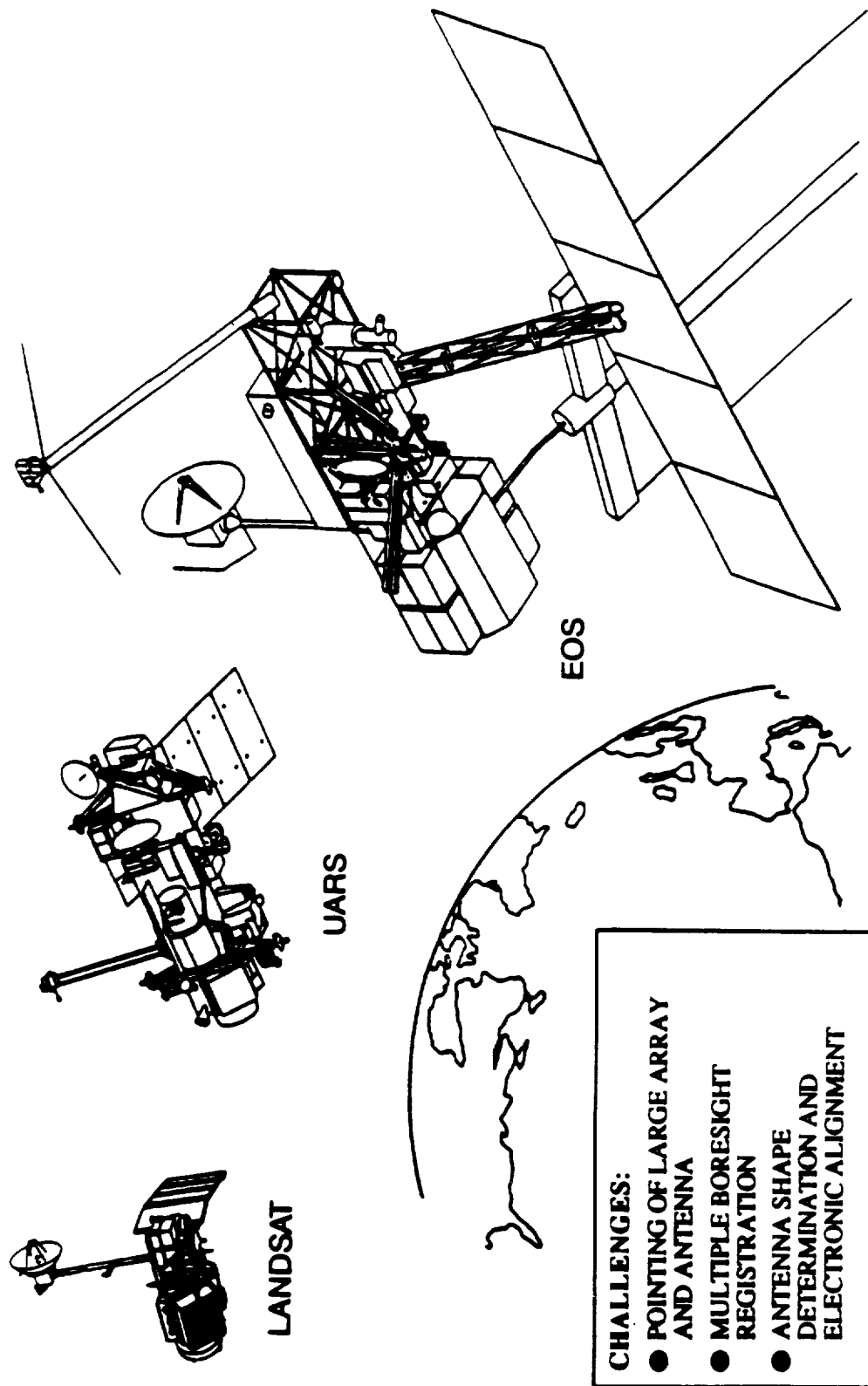


PROBLEM:
LACK OF QUICK DIAGNOSTIC TOOL
FOR ANOMALY INVESTIGATION
LEAD TO CONCERNS IN TURN
AROUND TIME FOR OPERATIONS

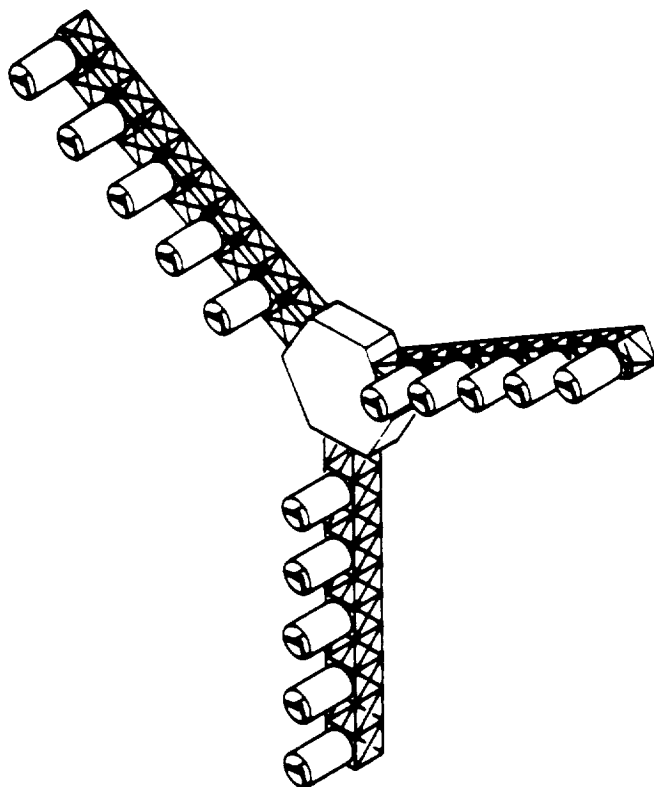
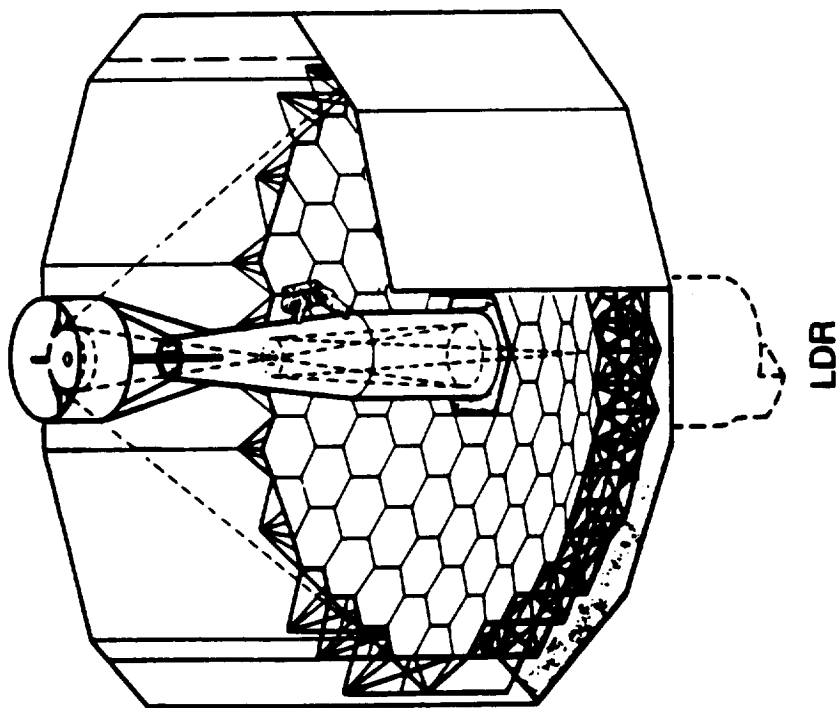
GROWTH IN SPACECRAFT MODELING COMPLEXITY



EVOLUTION OF EARTH OBSERVING PLATFORMS



ADVANCED ASTROPHYSICAL INSTRUMENTS

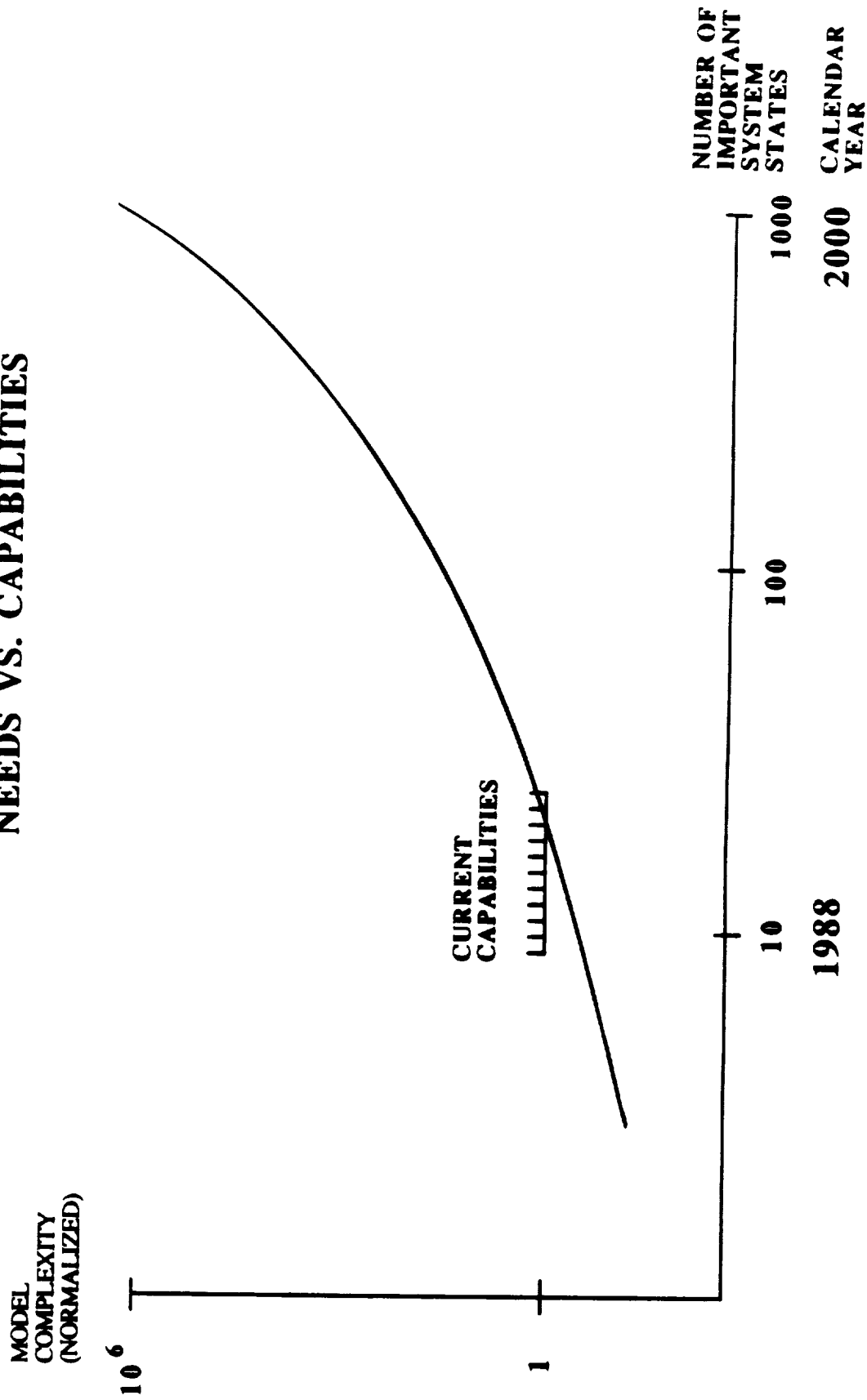


ASTROPHYSICAL INTERFEROMETER

CHALLENGES:

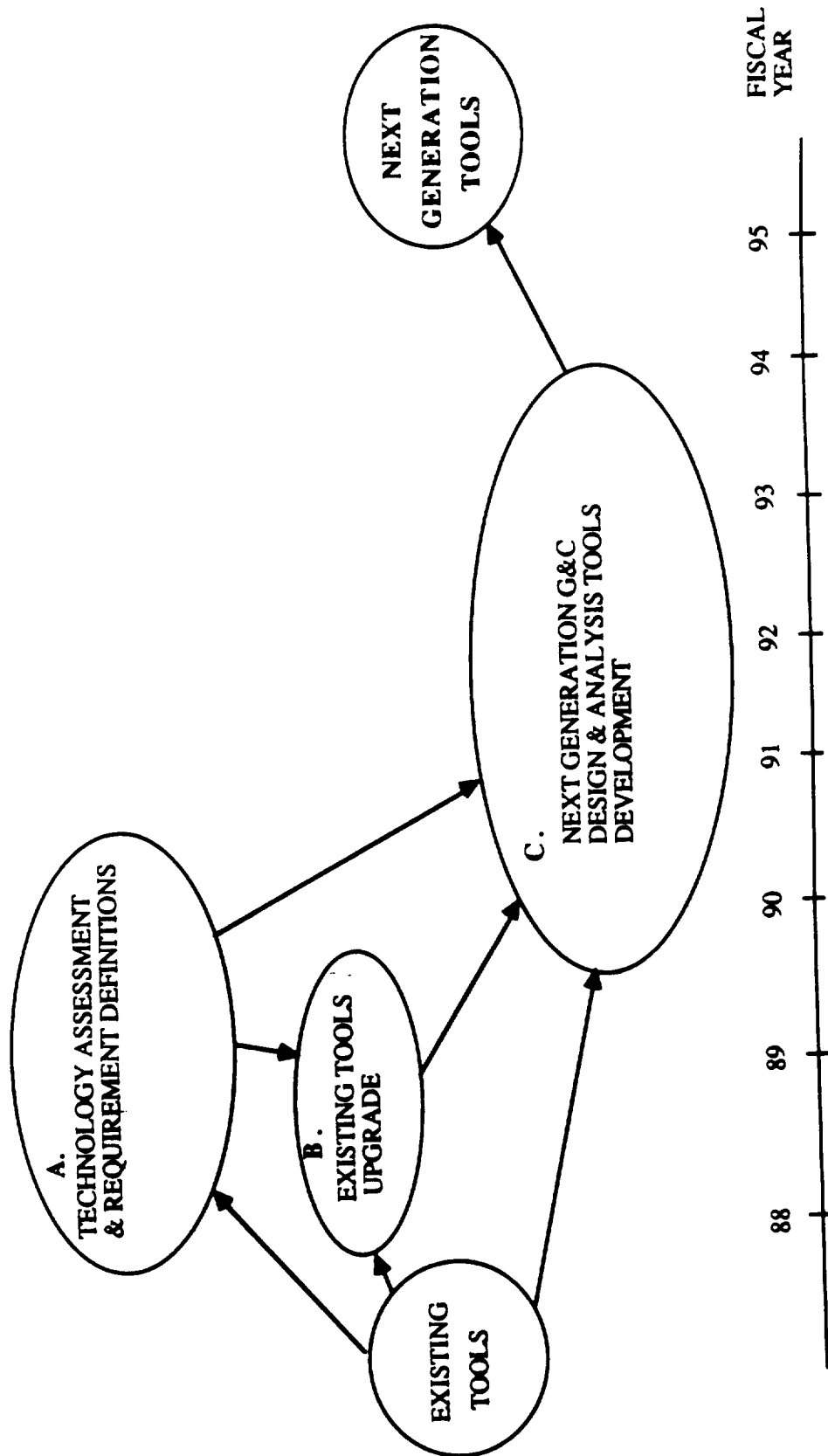
- SHAPE DETERMINATION AND ACTIVE CONTROL
- SUBWAVELENGTH PHASING OF OPTICAL PATHS
- DISTRIBUTED SENSING AND ACTUATION

CONTROL DESIGN AND ANALYSIS NEEDS VS. CAPABILITIES



EXISTING TOOLS ARE A LIMITING FACTOR IN TODAY'S CONTROL DESIGN AND VERIFICATION, AND ARE INADEQUATE FOR FUTURE NEEDS

COMPUTATIONAL CONTROLS APPROACH



COMPUTATIONAL CONTROLS APPROACH CONT.

A. TECHNOLOGY ASSESSMENT & REQUIREMENT DEFINITIONS

- MULTIBODY SIMULATION TECHNOLOGY VERIFICATION
- CONTROL SYSTEM DESIGN/ANALYSIS TOOL ASSESSMENT
- REQUIREMENT DEFINITION AND ANALYSIS

B. EXISTING TOOLS UPGRADE

- UPDATE TOOLS WITH KNOWN DEFICIENCIES
- UPGRADE TOOLS TO MEET NEAR TERM NEEDS

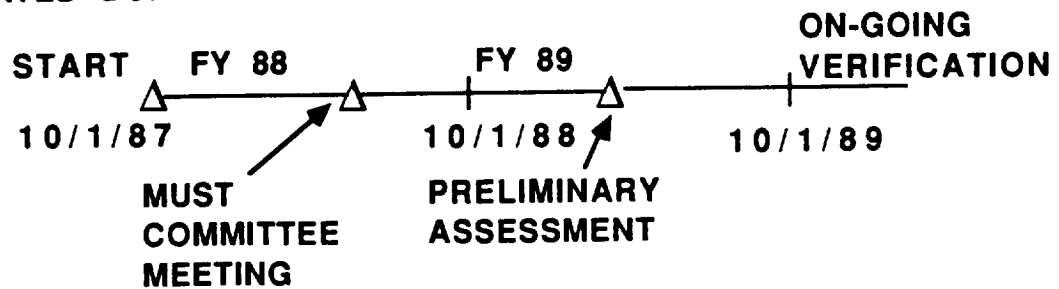
C. NEXT GENERATION TOOLS DEVELOPMENTS

- MULTIBODY SIMULATION TOOLS
- CONTROL SYSTEM OPTIMIZATION
- TOOLS FOR MODERN COMPUTING ENVIRONMENT
- ACCURATE SURFACE MODELING & REPRESENTATION TOOLS
- INTEGRATED CONTROL DESIGN ENVIRONMENT

MULTIBODY SIMULATION ASSESSMENT & VERIFICATION PLAN

PLAN SUMMARY:

● ESTIMATED DURATION:



SCHEDULE:

1ST YEAR

- REQUIREMENT DEFINITION AND ANALYSIS
- ESTABLISH VERIFICATION LIBRARY
- TEST CASE DEVELOPMENT

2ND YEAR

- TEST CASE EXECUTION AND EVALUATION
- EXPERIMENT EXECUTION AND EVALUATION
- TEST REPORT GENERATION

FUTURE YEARS:

- CONTINUE TO BUILD VERIFICATION LIBRARY
- VERIFY NEW TOOLS AS THEY ARE DEVELOPED

DELIVERABLES:

- QUESTIONNAIRES
- REQUIREMENTS MATRIX
- TEST PLAN
- TEST CASE REPORT
- FINAL REPORT
- TWO WORKSHOPS
- COMPUTATIONAL ASPECTS OF FLEXIBLE BODY SYSTEMS
- FINAL REPORT TO THE COMMUNITY

JPL		MULTIBODY SIMULATION TECHNOLOGY ASSESSMENT AND VERIFICATION PLAN																																					
MILESTONES		FY'87												FY'88												FY'89													
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1	SETUP ORGANIZATIONAL MECHANISM																																						
2																																							
3	REQUIREMENT DEFINITION																																						
4	MISSION REQUIREMENTS																																						
5	SIMULATION REQUIREMENTS																																						
6																																							
7	CODE ANALYSIS & TEST CASE DEV																																						
8	SIMPLE AND COMPLEX MODELS																																						
9																																							
10	EXPERIMENT DESIGN																																						
11	GROUND (NASA)																																						
12	ON-ORBIT																																						
13																																							
14	TEST EXECUTION AND EVALUATION																																						
15	SIMULATION																																						
16	IN-ORBIT (LACE)																																						
17																																							
18	TEST REPORT GENERATION																																						
19	WORKSHOPS																																						
20	MUST COMMITTEE MEETINGS																																						
21																																							
22	MUST ASSESSMENT																																						
23	MUST VERIFICATION																																						